GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

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| Subject name and code | Chemical power sources, PG_00037313 | | |
| Field of study | Technical Physics | | |
| Date of commencement of studies | October 2020 | Academic year of realisation of subject | 2022/2023 |
| Education level | first-cycle studies | Subject group | Optional subject group<br>Subject group related to scientific research in the field of study |
| Mode of study | Full-time studies | Mode of delivery | at the university |
| Year of study | 3 | Language of instruction | Polish |
| Semester of study | 6 | ECTS credits | 2.0 |
| Learning profile | general academic profile | Assessment form | assessment |
| Conducting unit | Department of Chemistry and Technology of Functional Materials -> Faculty of Chemistry | | |
| Name and surname of lecturer (lecturers) | Subject supervisor | prof. dr hab. Anna Lisowska-Oleksiak | |
| | Teachers | prof. dr hab. Anna Lisowska-Oleksiak<br>Zuzanna Zarach<br>Zuzanna Zarach | |

| Lesson types and methods of instruction | Lesson type | Lecture | Tutorial | Laboratory | Project | Seminar | SUM |
|---|---|---|---|---|---|---|---|
| | Number of study hours | 15.0 | 0.0 | 15.0 | 0.0 | 0.0 | 30 |
| | E-learning hours included: 0.0 | | | | | | |

| Learning activity and number of study hours | Learning activity | Participation in didactic classes included in study plan | Participation in consultation hours | Self-study | SUM |
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| | Number of study hours | 30 | 2.0 | 18.0 | 50 |

**Subject objectives**

The aim of the course is to acquaint students with

a) the basics of electrochemistry in relation to chemical power sources (ChPS) and

b) the basic knowledge in chemistry of materials applicable in ChPS

**Learning outcomes**

| Course outcome | Subject outcome | Method of verification |
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| K6_W02 | knows the field of electrochemistry (electrodics and ionics), knows the measurement methods of electrochemistry, knows the rules for the selection of electrode and electrolyte materials in the context of environmental protection and access to mineral resources | [SW1] Assessment of factual knowledge |
| K6_W01 | understands the need to use electrochemical methods in energy storage and conversion in the context of global climate change and the necessary departure from the use of fossil fuels | [SW3] Assessment of knowledge contained in written work and projects<br>[SW1] Assessment of factual knowledge |
| K6_U01 | can obtain up-to-date information on the electrochemistry of energy storage and conversion | [SU4] Assessment of ability to use methods and tools<br>[SU1] Assessment of task fulfilment<br>[SU3] Assessment of ability to use knowledge gained from the subject |

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| Subject contents | 1. Electrochemistry<br><br>Ionics. Charge transport in the electrolytes; aqueous electrolytes, aprotic electrolytes, gel electrolytes, polymer electrolytes, solid state electrolytes.<br><br>Electrodics. The metal electrode / electrolyte interface, semiconductor/ electrolyte interface, membrane/ electrolyte interface, Nernst law. Kinetics of the electrode reaction , Butler-Volmer equation, exchange current density, overpotential, transference number. Diffusion control, Cottrel equation. Electro catalysis. New phase formation - electrocrystalization, electro-polymerization. Mechanism of chosen electrode processes: hydrogen oxidation, methanol oxidation, dioxygen reduction. Electrochemical methods: , chronovoltamperometry, chronopotentiometry, chronoamperometry.Impedance spectroscopy.<br><br>II Electric energy storage and conversion devices<br><br>A) Primary batteries: Zn-MnO2, Zn /AgO, metal-air batteries, lithium primary batteries, high volume (special purpose) batteries. Anode passivation - technological solution, Solid stet cathodes and liquid catohodes for Lithium primary batteries.<br><br>B) Secondary batteries, lead acid batteries, NiMH batteries lithium batteries, lithium -ion batteries, lithium polymer electrolyte batteries. Intercalation process, insertion into sp2 carbonaceous materials, electro-active polymers, etc. Redox flow cells Batteries recycling EU ROSH directive.<br><br>C) Electrochemical capacitors a) EDLC capacitors, b) super-capacitors pseudo-faradaic capacity c) hybrid electrodes systems . Electrode and electrolyte materials, electron collectors for aqueous and non-aqueous electrolytes.<br><br>D) Fuel cells - microbial fuel cells and bio-fuel cells, (SOFC, MCFC, PMFC, DMFC - catalyst for oxygen reduction in PMFC. Methanol oxidation, Hydrogen from water splitting.<br><br>E) Additional subject : Photoelectrochemical water splitting (PEC -photoelectrochemical cell) - basic rules for selection of efficient electrode materials. |
| Prerequisites and co-requisites | basic knowledge in chemistry |

Assessment methods and criteria

| Subject passing criteria | Passing threshold | Percentage of the final grade |
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| laboratory | 100.0% | 40.0% |
| lecture | 60.0% | 60.0% |

Recommended reading

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| Basic literature | 1.A. Kisza, Elektrodyka, WNT 2000<br><br>2. A. Kisza, Jonika , WNT 2000<br><br>3. A. Czerwinski, Ogniwa Baterie, Warszawa 2005<br><br>4. C.A.Vincent, B. Scrosati, Modern Batteries , New York, 1997<br><br>5. Ed. P.J. Gellings, H.J.M.Bouwmeester The CRS Hanbook of Solid State Electrochemistry, 1996<br><br>6. Instrukcje do ćwiczeń laboratoryjnych<br><br>7. Materiały do wykładu ppt (pdf) |
| Supplementary literature | Aktualne doniesienia z czasopism JRC |
| eResources addresses | Uzupełniające<br>Adresy na platformie eNauczanie:<br>Chemiczne Źródła Prądu 2023 - Moodle ID: 28990<br>https://enauczanie.pg.edu.pl/moodle/course/view.php?id=28990 |

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| Example issues/ example questions/ tasks being completed | 1. determination of overpotential in respect to hydrogen evolution on various electrodes,<br><br>2. Synthesis and characterization of electroactive polymer .<br><br>3.Prussian Blue analoques as electrodes for supecapacitors.<br><br>4. Titania as photoanode material - phtocurrent determination for ITO/TiO2, ITO/TiO2/BP<br><br>5.Gelium type electrolytes - conductivity measurements.<br><br>6. determination of chemical diffusion coefficient from cyclic voltammetry |
| Work placement | Not applicable |